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Figure 1: Cross-sectional view of a PEM unit cell. The fuel (H_2) is oxidized at the anode catalyst layer and the oxidant (O_2) is reduced at the cathode catalyst layer.

Figure 2: Three dimensional schematic of a representative section of a PEM fuel cell stack shown with cross-flow configuration. The two gas diffusion layers (GDL), the anode catalyst layer (ACL), proton exchange membrane (PEM) and cathode catalyst layer (CCL) shown here as separate layers constitute a membrane electrode assembly (MEA). An MEA together with the seal (not shown) constitutes a unitized electrode assembly (UEA). The ACL and CCL are thin layers consisting of catalyst supported on carbon and ionomer. The unit cell repeats itself in a PEM fuel cell stack.

Figure 3: Schematics of flow-field design patterns. Though basic design patterns are shown, a number of combinations of these design patterns are also used.

Figure 4: A simple schematic to show the experimental setup typically used to measure the current-voltage (polarization) curve, and hence the performance, of a PEM unit cell. The anode and cathode polarities are also shown.

Figure 5: The current-voltage (VI) curve of a PEMFC unit cell (blue line) shown along with the ideal VI curve (green line) and polarization losses (red lines) due to oxygen reduction and

hydrogen oxidation reactions and membrane resistance. Three main losses due to kinetics, ohmic and transport are also shown.

Figure 6: A quality control flow sheet for selecting components towards proper cell design and manufacturing.

Figure 7: Unit cell cost breakdown by individual components (left) and further breakdown of the MEA cost due to membrane, electrode and GDL (right). Note that this cost analysis takes into account certain design assumptions and material selections.

Figure 8: Schematic of the MEA showing the important reactions and fluxes of key species in a PEM unit cell. The reactions in dashed boxes cause or contribute to membrane degradation and have important consequences towards PEMFC durability.